



## General

### Guideline Title

ACR Appropriateness Criteria® primary bone tumors.

### Bibliographic Source(s)

Morrison WB, Weissman BN, Kransdorf MJ, Adler R, Appel M, Bernard SA, Bruno MA, Fries IB, Germano I, Holly LT, Mosher TJ, Olson JJ, Palestro CJ, Roberts CC, Tuite MJ, Ward RJ, Zoga AC, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® primary bone tumors. [online publication]. Reston (VA): American College of Radiology (ACR); 2013. 12 p. [38 references]

### Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Morrison WB, Zoga AC, Daffner RH, Weissman BN, Bancroft L, Bennett DL, Blebea JS, Fries IB, Jacobson JA, Payne WK, Resnik CS, Roberts CC, Schweitzer ME, Seeger LL, Taljanovic M, Wise JN, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® primary bone tumors. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 6 p.

## Recommendations

### Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Primary Bone Tumors

Variant 1: Screening. First study.

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9	This procedure is absolutely required in a patient with suspected bone lesion.	Varies
US area of interest	1		O
MRI area of interest without and with contrast	1		O
RRL Legend: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			Relative

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body			<input type="text"/> <input type="text"/>
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
FDG-PET/CT whole body	1		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Positive localized or regional symptoms. Radiographs negative or findings do not explain symptoms.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	9		O
MRI area of interest without and with contrast	7	See statement regarding contrast in text below under "Anticipated Exceptions."	O
Tc-99m bone scan whole body	5	Perform this procedure if better localization is needed.	<input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest without contrast	5	This procedure may be useful for certain types of tumors.	Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
US area of interest	1		O
FDG-PET/CT whole body	1		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Lesion on radiographs definitively benign. Not osteoid osteoma.

Radiologic Procedure	Rating	Comments	RRL*
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Radiologic Procedure	Rating	Comments	RRL*
CT area of interest without contrast	4	Perform this procedure if the patient is symptomatic locally.	Varies
MRI area of interest without contrast	4	Perform this procedure if the patient is symptomatic locally.	O
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
US area of interest	1		O
MRI area of interest without and with contrast	1		O
Tc-99m bone scan whole body	1		<input type="text"/> <input type="text"/> <input type="text"/>
FDG-PET/CT whole body	1		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Lesion on radiographs. Radiographic and/or clinical pattern suspicious for osteoid osteoma.

Radiologic Procedure	Rating	Comments	RRL*
CT area of interest without contrast	9		Varies
MRI area of interest without and with contrast	6	Dynamic contrast enhancement may be valuable in this procedure. See statement regarding contrast in text below under "Anticipated Exceptions."	O
MRI area of interest without contrast	5		O
Tc-99m bone scan whole body	4	SPECT might be useful as an adjunct to this procedure.	<input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
US area of interest	1		O
FDG-PET/CT whole body	1		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation

Radiologic Procedure	Rating	Comments	Level RRL*
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Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: Lesion on radiographs. Indeterminate for malignancy with mineralized matrix.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without and with contrast	8	See statement regarding contrast in text below under "Anticipated Exceptions."	O
MRI area of interest without contrast	7		O
CT area of interest without contrast	7		Varies
Tc-99m bone scan whole body	5	This procedure may be helpful when evaluating for disease distribution or other areas of involvement.	<input type="text"/> <input type="text"/> <input type="text"/>
FDG-PET/CT whole body	3		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest without and with contrast	2		Varies
CT area of interest with contrast	1		Varies
US area of interest	1		O
X-ray radiographic survey whole body	1		<input type="text"/> <input type="text"/> <input type="text"/>
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Lesion on radiographs. Indeterminate for malignancy. Lytic lesion.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without and with contrast	8	See statement regarding contrast in text below under "Anticipated Exceptions."	O
MRI area of interest without contrast	7		O
CT area of interest without contrast	7		Varies
X-ray radiographic survey whole body	5	Perform this procedure if there is concern that the lesion represents multiple myeloma.	<input type="text"/> <input type="text"/> <input type="text"/>
Tc-99m bone scan whole body	5	This procedure may be helpful when evaluating for disease distribution or other areas of involvement.	<input type="text"/> <input type="text"/> <input type="text"/>
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate if MRI is contraindicated.			*Relative Radiation Level

Contrast Radiologic Procedure	Rating	Comments	RRL*
FDG-PET/CT whole body	3		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest with contrast	2		Varies
US area of interest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 7: Lesion on radiographs. Indeterminate for malignancy. Sclerotic or mixed lytic/sclerotic lesion.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without and with contrast	8	See statement regarding contrast in text below under "Anticipated Exceptions."	O
MRI area of interest without contrast	7		O
CT area of interest without contrast	7		Varies
Tc-99m bone scan whole body	5		<input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest without and with contrast	4	Perform this procedure if MRI is contraindicated.	Varies
FDG-PET/CT whole body	3		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
X-ray radiographic survey whole body	2		<input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest with contrast	2		Varies
US area of interest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 8: Lesion on radiographs. Aggressive, suspicious for malignancy.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without and with contrast	8	See statement regarding contrast in text below under "Anticipated Exceptions."	O

Contrast Radiologic Procedure	Rating	"Anticipated Exceptions."	RRL*
MRI area of interest without contrast	8		O
CT area of interest without contrast	7	This procedure is especially useful for areas with complex osseous anatomy.	Varies
Tc-99m bone scan whole body	6	This procedure is particularly helpful to look for multifocal disease.	<input type="text"/> <input type="text"/> <input type="text"/>
X-ray radiographic survey whole body	5	Perform this procedure if there is concern that the lesion represents multiple myeloma.	<input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest without and with contrast	5	Perform this procedure if MRI is contraindicated.	Varies
FDG-PET/CT whole body	5	This procedure is particularly helpful to look for multifocal disease.	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest with contrast	2		Varies
US area of interest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 9: Lesion with pathological fracture on radiographs. Not definitively benign.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without and with contrast	8	See statement regarding contrast in text below under "Anticipated Exceptions."	O
MRI area of interest without contrast	7		O
CT area of interest without contrast	5		Varies
Tc-99m bone scan whole body	5	This procedure is particularly helpful to look for multifocal disease.	<input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest without and with contrast	4	Perform this procedure if MRI is contraindicated.	Varies
FDG-PET/CT whole body	4		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest with contrast	2		Varies
US area of interest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Radiologic Procedure Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate	Rating	Comments	RRL* *Relative
			Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 10: No radiographs. "Incidental" finding on MRI. Not clearly benign.

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9		Varies
MRI area of interest without and with contrast	5	Use of this procedure depends on size and location in addition to sequences and field of view on original MRI. See statement regarding contrast in text below under "Anticipated Exceptions."	O
MRI area of interest without contrast	5	Use of this procedure depends on size and location in addition to sequences and field of view on original MRI.	O
CT area of interest without contrast	5		Varies
FDG-PET/CT whole body	2		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Tc-99m bone scan whole body	1		<input type="text"/> <input type="text"/> <input type="text"/>
US area of interest	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 11: No radiographs. "Incidental" finding on CT. Not clearly benign.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	9		O
MRI area of interest without and with contrast	7	See statement regarding contrast in text below under "Anticipated Exceptions."	O
X-ray area of interest	5	Use of this procedure depends on size and location in addition to adequacy of initial CT evaluation.	Varies
Tc-99m bone scan whole body	1		*Relative Radiation Level

Radiologic Procedure	Rating	Comments	RRL*
CT area of interest without contrast	3	Use of this procedure depends on the quality of the original CT. A focused study may be helpful in some cases.	Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
FDG-PET/CT whole body	1		<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
US area of interest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

## Summary of Literature Review

### Introduction/Background

Numerous imaging techniques are available for evaluating bone tumors. However, radiographs remain the primary screening technique and are the least expensive methods of detecting and histologically characterizing many tumors or tumor-like conditions of bone. When a classically nonaggressive lesion is detected on routine radiographs, additional studies may not be required unless surgical intervention is contemplated and further anatomic information is required. In this setting either computed tomography (CT) or magnetic resonance imaging (MRI) may be most appropriate for additional characterization and preoperative evaluation.

### Magnetic Resonance Imaging and Computed Tomography

When radiographic features are indeterminate or the lesion is more aggressive and considered to be potentially malignant, additional imaging studies are frequently required. In the past, radionuclide imaging was used to evaluate bone lesions in this setting. However, today, because of the improved anatomic detail and sensitivity of MRI, it is preferred over radionuclide studies. Early evaluation of MRI and CT demonstrated that MRI was superior for staging of bone tumors before treatment. Two studies described MRI and CT features of bone tumors with regard to cortical destruction, marrow, soft-tissue, joint, and neurovascular involvement. One of the studies reported that MRI was superior to CT in detecting cortical bone destruction in 4.5% of patients studied, for marrow involvement in 25%, for soft-tissue involvement in 31%, for joint involvement in 36.4%, and for invasion of neurovascular structures in 15.3%. In the same categories, MRI and CT were felt to be equal in 63% to 82% of patients. CT was superior to MRI in detecting cortical bone destruction in 13.6% of patients and neurovascular involvement in 7.7%. However, another study more recently showed no difference between CT and MRI for evaluation of extent of tumor involvement in 183 patients with primary bone tumors, suggesting that both are equally accurate for staging purposes. Comparison studies are not recent, and evolution of technology may limit relevance of these data.

In most institutions the imaging technique depends on patient status as well as the location and type of suspected lesion. MRI is most typically used for staging lesions in the extremities. Intravenous contrast dye can be useful to determine vascularity of lesions, detect vascular invasion, and identify necrotic or cystic areas. MR spectroscopy has potential to differentiate benign from malignant lesions, but more research is needed. CT is usually preferred when tumors are located within the periosteal or cortical regions, with flat bones with thin cortex and little marrow, as well as in small bones such as those in the hands and feet, in which case higher resolution can be advantageous. CT can better demonstrate tumor mineralization, which may be suspected or indeterminate on radiographs. CT may also be preferred in certain circumstances where characterization of osseous anatomy and proximity to other structures is paramount, including pelvis and spine. For rib lesions, thin-section CT is useful to exclude fracture through a nonaggressive lesion or to differentiate traumatic versus pathological fracture. CT is also preferred over MRI for detecting a characteristic central nidus in patients with suspected osteoid osteoma on radiographs.

### Positron Emission Tomography (PET)

PET scanning has been used with success for detecting metabolically active metastatic lesions or recurrences and for preoperative evaluation of



known sarcomas. Data can be co-registered with CT or MRI to correlate with anatomic information. PET has shown promise in helping differentiate benign from malignant bone lesions. However, although studies have found significant differences in the average maximum standard uptake value ( $SUV_{max}$ ) between benign and malignant groups, there is significant overlap in individual tumor types, reflecting variegated metabolic activity in different lesions and complicating myxoid and necrotic components with low metabolic activity. Studies have predominantly been performed on mixed lesion types, with few individual entities that could provide information regarding evaluation of specific tumor types for malignant potential. One study found that PET with fluorine-18-2-fluoro-2-deoxy-D-glucose tracer (FDG-PET) can help differentiate benign from malignant spinal compression fractures with a sensitivity of 86% and specificity of 83%; however, there was overlap in the range of SUV in the benign and malignant groups. Also, there have been reports of nontumor conditions (especially inflammatory entities) that can also result in abnormal uptake.

The role of PET scanning in the workup of bone tumors has yet to be established. A lesion with indeterminate aggressiveness on radiographs with little to no increased uptake on PET scan could potentially undergo more conservative follow-up; however, more research is required in this regard. It seems clear that PET can provide more information, especially in patients who cannot undergo MRI and in situations where biopsy is not feasible due to location or patient condition. It can also be used to help plan biopsy, with PET/CT fusion images used to target areas with more cellular metabolic activity that may give higher diagnostic yield.

### Ultrasound (US)

Although focused musculoskeletal US with Doppler flow analysis can be a useful tool with some primary osseous and soft-tissue tumors, it is not considered a first-line modality. It should be considered when the size of the lesion renders imaging with pre-contrast-enhanced and post-contrast-enhanced MRI incomplete or when assessment of echotexture and vascularity might decrease the size of the differential after complete assessment with MRI and CT. However, such a US assessment requires a skilled sonographer, and there is little in the medical literature describing differentiating characteristics of musculoskeletal tumors on US.

### Angiography

Angiography is not generally indicated except in specialized individual circumstances. Information from invasive diagnostic procedures (except biopsy) has been effectively replaced by noninvasive advanced imaging techniques.

### Evaluation of Lytic Lesions Versus Lesions with Sclerotic Features

Lesions seen on radiographs may require additional characterization using advanced imaging examinations; the next appropriate examination may depend on the nature of the lesion: lytic versus sclerotic. For example, a purely lytic lesion may need to be further characterized as solid or cystic not only to narrow the differential diagnosis but also to help guide treatment and biopsy planning (i.e., to avoid necrotic or myxoid areas). In this case MRI may be most useful. For mixed lytic/sclerotic or sclerotic lesions there may be matrix mineralization better characterized on CT. Or, if purely sclerotic the differential may be a bone island versus an osteoblastic tumor, in which case a bone scan may be the most useful test.

### Chondroid Lesions

There are special considerations when dealing with a suspected chondroid lesion. Intramedullary chondroid lesions appearing in the hands and feet are nearly always benign and may present incidentally or as a pathological fracture. If the lesion is elsewhere it may be challenging to differentiate a benign lesion from a low-grade malignancy using any imaging modality. If there is pain related to the lesion, suspicion of malignancy should be high. However, care should be taken to exclude adjacent joint pathology as the source of pain, which may require advanced imaging. A study of 57 patients presenting to an orthopedic oncologist with shoulder pain and a cartilage tumor showed that 82% had shoulder imaging findings that could explain the pain. Once other etiologies for the pain have been excluded, some radiologic findings have been useful in differentiating benign and malignant lesions. One study suggests that imaging features including deep endosteal scalloping, cortical destruction, soft-tissue mass (on CT or MRI), periosteal reaction (on radiographs), and marked uptake of radionuclide can be used to distinguish appendicular enchondroma from chondrosarcoma in at least 90% of cases. However, another study suggests that endosteal scalloping is seen in benign lesions. A third study suggests that radiographic signs cannot discriminate reliably between enchondroma and grade 1 chondrosarcoma, but axial location and large size (greater than 5 cm) are the most reliable predictors of malignancy in this setting. It has been suggested that dynamic contrast-enhanced MRI can assist in differentiating benign from malignant chondroid lesions, and PET may be useful; however, these modalities have not been clearly established for this purpose. Protocol for follow-up of an asymptomatic, incidentally identified lesion has not been scientifically established. Some researchers have suggested that the risk of malignant transformation is increased for larger lesions and lesions in the axial skeleton and in the setting of multiple lesions (e.g., Ollier disease). They suggest radiographic follow-up for those at higher risk but do not make specific recommendations regarding interval and extent of follow-up.

### Lesion Presenting with Pathological Fracture

Benign and malignant lesions can present with pathological fracture. Especially if imaging is delayed, hemorrhage and bone resorption can lead to a more aggressive appearance, making it difficult to assess for benign characteristics. Early imaging is essential to limit this detrimental effect. In this case, MRI can best evaluate for presence of an underlying lesion.

#### "Incidental Lesions" Found on CT or MRI

On other occasions lesions are incidentally found on advanced imaging studies and are indeterminate for malignancy. Other imaging examinations may be needed depending upon the findings and level of concern (i.e., history of cancer elsewhere). Radiographs are generally indicated for a lesion found on MRI, but a lesion suspected on CT may require an MRI or bone scan for further characterization.

#### Symptoms with Negative Radiographs

There is a wide differential for symptomatic patients who either have negative radiographs or have radiographs with findings that do not explain the pain. This includes injury such as stress fracture, early infection, or radiographically occult tumor. In any case, advanced imaging may be required based on history and degree of clinical concern. In this situation the referring physician should not be confident that there is no pathology if the radiographic result is negative or nonspecific; radiographs are often insensitive, especially in early disease.

Although CT may be performed in this setting, a radionuclide bone scan may be more useful to localize the abnormality. MRI can be very useful in this setting not only to identify whether a lesion is present but also to define the nature of a lesion based on the features discussed above; as a result, MRI is generally preferred. If an osteoid osteoma is suspected, one study reported that CT was more accurate than MRI in 63% of cases. However, another study reported that dynamic contrast-enhanced MRI can improve conspicuity of osteoid osteoma compared to CT. MRI is useful for determining tissue characteristics of a bone lesion, such as fat, hemorrhage, fibrous tissue, or fluid levels. With gadolinium contrast, cystic or necrotic areas can be detected.

#### Summary

- Routine radiographs remain the optimal screening technique for primary bone tumors.
- When lesions are characteristically nonaggressive, additional imaging may not be required unless needed for preoperative planning. The data suggest that MRI is the preferred technique for staging of primary bone neoplasms, but CT is equal or superior to MRI in some categories.
- CT is preferred for patients with suspected osteoid osteoma or subtle cortical abnormalities, and for evaluating matrix mineralization.
- Advanced imaging modalities provide complementary information and often more than one modality is required for diagnostic or preprocedure evaluation.

#### Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e.,  $<30$  mL/min/1.73 m<sup>2</sup>), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates  $<30$  mL/min/1.73 m<sup>2</sup>. For more information, see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

#### Abbreviations

- CT, computed tomography
- FDG-PET, fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography
- MRI, magnetic resonance imaging
- SPECT, single photon emission computed tomography
- Tc, technetium
- US, ultrasound

#### Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
<input type="text"/>	<0.1 mSv	<0.03 mSv

Relative Radiation Level*	Adult Effective Dose Estimate Range 0.1-1 mSv	Pediatric Effective Dose Estimate Range 0.03-0.3 mSv
<div><div></div><div></div><div></div></div>	1-10 mSv	0.3-3 mSv
<div><div></div><div></div><div></div><div></div></div>	10-30 mSv	3-10 mSv
<div><div></div><div></div><div></div><div></div><div></div></div>	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Primary bone tumors

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Internal Medicine

Nuclear Medicine

Oncology

Radiology

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for primary bone tumors

## Target Population

Patients with suspected or confirmed primary bone tumors

## Interventions and Practices Considered

1. X-ray area of interest
2. Ultrasound (US) area of interest
3. Magnetic resonance imaging (MRI) area of interest
  - Without and with contrast
  - Without contrast
4. Technetium (Tc)-99m bone scan whole body
5. Computed tomography (CT) area of interest
  - Without contrast
  - With contrast
  - Without and with contrast
6. Fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) whole body

## Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

## Methodology

### Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

### Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

Staff will search in PubMed only for peer reviewed medical literature for routine searches. Any article or guideline may be used by the author in the narrative but those materials may have been identified outside of the routine literature search process.

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 10 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

## Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

## Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis, and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid, but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

## Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

## Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence (study quality) for each article included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

## Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

## Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distribute surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The appropriateness rating scale is an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate"; 4, 5, or 6 are in the category "may be appropriate"; and 7, 8, or 9 are in the category "usually appropriate." Each panel member assigns one rating for each procedure for a clinical scenario. The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying

which members provided any particular rating.

If consensus is reached, the median rating is assigned as the panel's final recommendation/rating. Consensus is defined as eighty percent (80%) agreement within a rating category. A maximum of three rounds may be conducted to reach consensus. Consensus among the panel members must be achieved to determine the final rating for each procedure.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is proposed as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

This modified Delphi method enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive influence from fellow panelists in a simple, standardized and economical process. A more detailed explanation of the complete process can be found in additional methodology documents found on the [ACR Web site](#)  (see also the "Availability of Companion Documents" field).

## Rating Scheme for the Strength of the Recommendations

Not applicable

## Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

## Method of Guideline Validation

Internal Peer Review

## Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

## Evidence Supporting the Recommendations

### Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Selection of appropriate radiologic imaging procedures to evaluate patients with primary bone tumors or suspected of primary bone tumors

### Potential Harms

Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from

limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e.,  $<30$  mL/min/1.73 m<sup>2</sup>), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates  $<30$  mL/min/1.73 m<sup>2</sup>. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

#### Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

## Qualifying Statements

### Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

## Implementation of the Guideline

### Description of Implementation Strategy

An implementation strategy was not provided.

## Institute of Medicine (IOM) National Healthcare Quality Report Categories

### IOM Care Need

Living with Illness

### IOM Domain

## Identifying Information and Availability

### Bibliographic Source(s)

Morrison WB, Weissman BN, Kransdorf MJ, Adler R, Appel M, Bernard SA, Bruno MA, Fries IB, Germano I, Holly LT, Mosher TJ, Olson JJ, Palestro CJ, Roberts CC, Tuite MJ, Ward RJ, Zoga AC, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® primary bone tumors. [online publication]. Reston (VA): American College of Radiology (ACR); 2013. 12 p. [38 references]

### Adaptation

Not applicable: The guideline was not adapted from another source.

### Date Released

1995 (revised 2013)

### Guideline Developer(s)

American College of Radiology - Medical Specialty Society

### Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

### Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

### Composition of Group That Authored the Guideline

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### Financial Disclosures/Conflicts of Interest

Not stated

### Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Morrison WB, Zoga AC, Daffner RH, Weissman BN, Bancroft L, Bennett DL, Blebea JS, Fries IB, Jacobson JA, Payne WK, Resnik CS, Roberts CC, Schweitzer ME, Seeger LL, Taljanovic M, Wise JN, Expert Panel on Musculoskeletal



Imaging. ACR Appropriateness Criteria® primary bone tumors. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 6 p.

## Guideline Availability

Electronic copies: Available from the [American College of Radiology \(ACR\) Web site](#) .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

## Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in Portable Document Format (PDF) from the [American College of Radiology \(ACR\) Web site](#) .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2013 Apr. 1 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2013 Nov. 2 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2013 Apr. 1 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria® primary bone tumors. Evidence table. Reston (VA): American College of Radiology; 2013. 15 p. Electronic copies: Available from the [ACR Web site](#) .

## Patient Resources

None available

## NGC Status

This summary was completed by ECRI on May 6, 2001. The information was verified by the guideline developer as of June 29, 2001. This summary was updated by ECRI on March 27, 2006. This summary was updated by ECRI Institute on May 17, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Gadolinium-based contrast agents. This summary was updated by ECRI Institute on June 20, 2007 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on May 21, 2010. This summary was updated by ECRI Institute on January 13, 2011 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on February 27, 2014.

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